HARDWARE/SOFTWARE MANAGEMENT, PURCHASING AND OPTIMIZATION SYSTEM

RELATED APPLICATIONS

This application claims the priority of Provisional Application Serial No. 60/099,629, filed September 8, 1998.

BACKGROUND OF THE INVENTION

The present invention relates to the management of the hardware and software of data centers and, more particularly, to the management of information about existing, planned or proposed hardware and software assets of the data centers.

Data center managers, capacity planners and financial planners are periodically required to evaluate the technical capabilities, financial requirements and environmental requirements of the hardware and software of computer data centers, networks, corporate IT assets and other collections of computer hardware and software. The term "data center" is meant here to be broad enough to encompass any or combinations of the foregoing. The managers and planners must also periodically determine whether or not to modify, upgrade or replace the existing hardware and software or whether to purchase additional hardware or software.

Typically, the only sources of information are from sales literature and from the sales representatives of new hardware and software products. The sales representatives are not likely to be familiar with the technical, financial and environmental requirements of

existing data centers. The data center managers, capacity planners and financial planners thus do not presently have a good methodology for evaluating existing software and hardware, determining whether to purchase or lease new hardware and software, upgrade existing hardware and software or to dispose of existing hardware or software. There is currently no reliable methodology for determining the financial and environmental costs of such changes. Though spreadsheet products are currently available, the spreadsheets do not take into account all the parameters of existing data centers.

It is therefore desirable to provide an apparatus for and a method of tracking the technical specifications, costs and environmental details of existing data centers as well as for determining the optimum acquisition, expansion and reconfiguration strategies for the data centers.

SUMMARY OF THE INVENTION

The present invention provides for tracking and day-to-day management of technical requirements, costs and environmental details of existing data centers, and the creation of scenarios for determining the optimum acquisition, expansion and reconfiguration strategies of the data centers as well as the forecasting of technical requirements, costs and environmental requirements of existing and proposed configurations of the data centers.

The invention includes a knowledge base comprised of the technical and financial specifications of various storage devices and other software and hardware. A modeling tool allows for the creation of various "What-If" scenarios of possible data center configurations for making long term projections of the

technical and financial requirements of existing, modified or proposed data center configurations. The costs of individual devices, systems or data center locations, as well as the costs of proposed new equipment are tracked.

The invention also includes the ability to present technical, financial and other information of a data center at various levels, namely at the configuration, location, system and individual device levels, and the ability to prepare custom reports, tables and charts of the information.

An aspect of the invention includes an apparatus for and a method of managing hardware and software of at least one data center. Information concerning a plurality of devices is stored. One or more configurations include at least one location, at least one system within the location, at least one device group within the system, and at least one device within a device group are stored. Information that is associated with each element of the configuration is correlated and stored. A display comprising at least a portion of the configuration and at least a portion of the associated information is generated.

In accordance with this aspect of the invention, the associated information may include financial information, technical information, or a summary of financial and technical information of at least one of the locations, systems, device groups and devices of the configuration. The associated information may include contact and lessor information or history information of a device. Table information of at least a portion of the associated information of selected locations, systems, device groups and devices over a

selected time interval may be generated, and a chart representing the table information may likewise be generated. A report of at least a portion of the configuration of the associated information may be generated. The configuration and associated information and the information concerning the devices may be edited.

Another aspect of the invention includes a method of and an apparatus for adding a new location to a configuration of at least one data center. A new location transaction is selected, and a name of a new location within the configuration is entered.

A further aspect of the invention includes a method of and an apparatus for adding a new system to a configuration of at least one data center. A location within the configuration is selected, and the name of a new system within the location is entered.

A still further aspect of the invention includes a method of and an apparatus for adding a new device to a configuration of at least one data center. A desired device type is selected, and the system within the configuration within the desired device type is to be added is selected. The desired device type is added to the system, and a device model is assigned to the device type. Further associated information is assigned to the device model.

In accordance with this aspect of the invention, the further associated information may include one or more of financial information, technical information and custom information.

Yet another aspect of the invention includes a method of and an apparatus for updating information in a configuration of at least one data center. A device of a configuration that is to be updated is selected, and a

portion of the associated information corresponding to the selected device is selected. The portion of the associated information is updated.

An additional aspect of the invention includes a method of and an apparatus for moving a device within a configuration of at least one data center. The device within a system of the configuration that is to be moved is selected, and another system to which the selected device is to be moved is selected. A date that the selected device is to be moved is selected.

A further additional aspect of the invention includes a method of and an apparatus for disposing of a device in a configuration of at least one data center. A device within the configuration that is to be disposed is selected, and a disposal date is selected.

Yet still another aspect of the invention includes a method of and an apparatus for modeling proposed changes to a configuration of at least one data center. An existing configuration is selected, and at least one modification to the existing configuration is performed. A modification date for the modification is selected.

In accordance with this aspect of the invention, the modifications may include adding at least one device to the selected configuration, moving at least one device within the selected configuration, and disposing of at least one device within the selected configuration. Another proposed configuration may be generated, and a table or a chart may be generated for comparing the proposed configurations.

Other features and advantages of the present invention will become apparent from the following

description of the invention which refers to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described in greater detail in the following detailed description with reference to the drawings in which:

Figure 1 is a block diagram showing a computer system in accordance with the present invention.

Figure 2 is a block diagram showing the knowledge base of Figure 1.

Figure 3 is a block diagram showing the configuration storage of Figure 1.

Figures 4A-4E show an example of the respective levels of a configuration stored in the configuration storage of Figure 3.

Figure 5 is a block diagram showing the display generator of Figure 1.

Figure 6 shows an example of a display generated by the display generator of Figure 5.

Figure 7 is a block diagram showing the information tabs data of the display generator of Figure 5.

Figures 8A-8B shows an example of the financial specifications displayed when the financial tab of the information tabs of Figure 7 is selected.

Figures 9A-9B shows an example of the technical specifications displayed when the technical tab of the information tabs of Figure 7 is selected.

Figure 10A shows an example of the summary, technical and financial specifications that are displayed when the summary tab of the information tabs of Figure 7

is selected. Figure 10B shows the contact and lessor information displayed when the contact/lessor tab of the information tabs of Figure 7 is selected. Figure 10 shows the history data displayed when the history tab of the information tabs of Figure 7 is selected.

Figure 11 and 11B show examples of tables generated by the table generator of Figure 1.

Figure 12 shows an example of a chart generated by the chart generator of Figure 1.

Figure 13A is a flow chart illustrating the flow of a Select New Location transaction, and Figure 13B illustrates an example of a displayed representation of a Select New Location transaction.

Figure 14A is a flow chart illustrating the flow of a Select New System transaction, and Figure 14B illustrates an example of a display of a Select New System transaction.

Figures 15A-15B are flow charts illustrating the flow of a Select New Acquisition transaction.

Figures 16A-16G show examples of displayed representations of several of the steps of Figures 15A-15B.

Figure 17 is a flow chart illustrating the flow of an Update operation.

Figures 18A-18C show examples of displayed representations of steps in the operation of Figure 17.

Figure 19 is a flow chart illustrating the flow of a Move transaction.

Figures 20A-20B show examples of displayed representations of an example of the operation of Figure 19.

Figure 21 is a flow chart illustrating the flow of a Device Disposition transaction.

Figure 22A is a flow chart illustrating the flow of a What-If Configuration transaction. Figure 22B shows an example of a displayed representation of the operation of Figure 22A.

Figure 23 is a flow chart illustrating the flow of a chart generation operation.

Figures 24A and 24B show examples of a displayed representation of the operation of Figure 24A.

DETAILED DESCRIPTION OF THE INVENTION

Referring first to Figure 1, there is shown a computer system 10 in accordance with the invention with its various portions illustrated in block form. The computer system 10 includes an operating system 20, which may be a conventional operating system such as Windows 95, Window 98, Windows NT, or Windows 3.1X.

Also included are a knowledge base 30 for storing financial and technical information of various hardware devices and/or software products, a configuration storage 40 for storing one or more configuration trees representing existing and proposed configurations of the data centers, and a correlator 45 for correlating the financial and technical information stored in the knowledge base with the elements of the configuration trees for storage in the configuration storage. Further included are a table generator 60 for generating a table or grid displaying financial and summary information of one or more of the configurations or portions of configurations, a report generator 70 for generating a printed report of a configuration or a portion of a configuration, and a chart generator 80 for generating information generated by the table generator in graphic form. A display generator 50 generates a

visual representation of, for example, part or all of a configuration stored in configuration storage 40 together with its associated information from the correlator 45 and the knowledge base 30 for a display 90. Additionally, grid information generated by the table generator 60 is formatted by the display generator 50. Alternatively, the representation of one or more charts generated by the chart generator 80 are formatted for display by the display generator.

The knowledge base 30, shown in greater detail in Figure 2, includes one or more databases of user supplied financial information 34 and user supplied technical information 36 of various devices. Also included in the knowledge base are user supplied contact and lessor information 38 for the devices and other user supplied information 39. Further included are default data 32 including financial and technical information of other devices not supplied by the user.

An editor 55, shown in Figure 1, is included for modifying the user supplied information in the knowledge base and the configuration storage.

Figure 3 shows, in greater detail, the configuration storage 40 which is comprised of one or more configurations 40A, 40B, 40C,... Each configuration includes at least one data center location having at least one system which, in turn, includes at least one device group. Each device group, in turn, includes one or more devices. The configuration is stored in a tree data structure in which the highest level represents the respective configuration, the second level of the tree represents the data center locations within the configuration, the third level represents the systems within a respective location, the fourth level of the

data structure represents the device groups within a respective system, and the fifth level represents the devices under a respective device group.

Figures 4A-4E show an example of a display of the respective levels of a configuration tree that are generated by the display generator 50. Figure 4A shows a representation of the first level, namely the configuration, which is called in this example the Sample Configuration. Figure 4B shows a representation of the first and second levels of the example, namely two data center locations within the Sample Configuration. Figure 4C shows the first through third levels which includes the respective systems of each of the two locations, and Figure 4D shows the first through fourth levels which may include, for example, a control unit, a DASD, a processor and a RAID. Figure 4E shows the first through fifth levels which includes the respective devices of each device group. In accordance with the invention, the display generator 50 may be instructed to generate a display of between one to all five of the configuration tree levels, as shown in Figure 4A-4E.

Figure 5 shows a block representation of the display generator 50 in greater detail. The display generator generates a representation of part or all of a configuration tree 52, together with selected portions of its associated information 55, over a date range 57. Figure 6 illustrates an example of a display generated by the display generator 50.

The display generator 50 may also incorporate a months grid 56 which may display financial information or summaries of financial information of one or more locations, systems, device types, manufacturers, devices, and models over a selected number or months as well as

The system level financial specifications include the air conditioning cost per BTU, if different from that of the configuration of the respective data center, and the overhead costs.

The device level financial specifications include the acquisition date, the maintenance per month, the maintenance delay, the monthly overhead costs, the financial life, the transaction start date, the acquisition cost, the salvage value, the depreciation method (if the device is purchased), the monthly lease cost and lease buyout cost (if the device is leased), the remaining book value, the device serial number, the order date, the delivery date, the installation date and the invoice date.

Figures 9A-9B show examples of displays generated by the display generator 50 when the technical tab 54B is selected. Specifically, Figure 9A shows an example of the technical information of a respective device in the configuration tree, and Figure 9B shows an example of the technical information of a system.

The technical information of a device may include the device type, the device manufacturer, the device model number, the device serial number, the area used, the BTUs, and the power consumed in KVA. If the device is a DASD, the technical information may also include the capacity per unit, the number of cylinders per device, the data transfer rate, the number of physical device addresses per unit, and the number of tracks per cylinder. For a RAID, the technical information may also include the capacity per unit, the logical device addresses, the cache, the number of ESCON channels, the number of logical channels, and the number of OEMI host adapters. For a control unit, the technical

the total cost of ownership (TCO) and the totals. Additionally, the display generator generates information tabs 54, shown in greater detail in Figure 7, which include a financial tab 54A showing that financial information is being displayed, a technical tab 54B showing that technical information is being displayed, a summary tab 54B showing that summary information is being displayed, a contact/lessor tab 54D or a history tab 54E.

Figure 8A-8B, 9A-9B, and 10A-10C, show examples of displays generated by the display generator 50 when one of the information tabs 54 is selected for a respective element in a configuration tree.

Figure 8A shows an example where the financial tab 54A is selected for a respective device in the configuration tree. Alternatively, the financial specifications of a respective device group, system, location or of an entire configuration may be selected. As an example, Figure 8B shows the financial specifications of a respective system.

The financial information for a respective configuration may include the cost of capital or cost of money, the air conditioning costs per BTU, the cost of electricity based on a per KVA basis, the cost of floor space per square foot, and/or the monthly overhead cost.

The financial specifications for a data center location may include its cost of capital, if different from that of the entire configuration, the air conditioning cost per BTU, if different from that of the configuration, the cost of electricity, if different from that of the configuration, the cost of floor space per square foot, if different from that of the configuration, the monthly overhead cost, and/or the total floor space.

information may also include the cache and the number of channel interfaces.

The technical specifications of a device group, system, location or configuration may also include totals of some or all of the above information.

Figure 10A shows an example of a display generated by the device generator 50 which shows a summary of the technical and financial specifications of a respective system. Alternatively, summary information of a configuration, or of one or more locations, systems or devices are shown.

Figure 10B shows an example of a display generated by display generator 50 which shows the associated contact and lessor information of a device when the contact/lessor tab 54D is selected.

Figure 10C shows an example of a display generated by the display generator 50 when the history tab 54E is selected and shows the history of a respective device.

Referring back to Figure 1, the table generator 60 generates a table displaying the technical information about selected levels of a configuration tree which, in turn, is formatted by the display generator 50 for display as the months grid 56.

Figure 11A shows an example of a representation of a months grid 56 which shows one or more locations, systems, device types, manufacturers, devices, models, TCOs, the monthly cost of ownership over three respective months and the total cost of ownership. Also shown are the totals for the two locations.

It should be noted that other information, such as the lease costs, maintenance costs, overhead costs, net remaining book value, total device area, total BTUs

or total capacity may be shown as set out in box 56A. The months grid 56 generated by table generator 60 and display generator 50 may display specific information pertaining to a date range as a function of one or more months over any level of the configuration tree. The months grid may also be used to show comparisons between respective devices, systems or locations. As an example, Figure 11B shows a representation of a months grid 56 that breaks out the monthly cost of ownership by device.

The respective locations, systems, device types, and devices that are selected for comparison in the months grid are selected from the configuration tree generated for display by the display generator 50, such as is shown in Figure 6, and the criteria used for comparison may be selected from the criteria shown in box 56A of Figure 11A.

A graphic representation of the information continued in months grid 56 may be generated by the chart generator 80 and formatted by the display generator 50. Figure 12 shows an example of a bar chart generated by the chart generator 80 and the display generator 50. Alternatively, stack charts, pie charts or other types of charts may be generated. It should be noted that charts representing information concerning one or more devices, device types, systems, locations or configurations may be displayed concurrently.

The report generator 70 shown in Figure 1 generates reports of selected degrees of detail which may be either printed out or formatted for display by the display generator 50. Figures 24A and 24B illustrate an example of a print report request. Each requested report begins from a first date in which the devices were acquired up to a specified date for an actual or a

proposed configuration. The type of report is also selected and may cover an entire configuration, a single location, a single system, the devices by lessor, the devices by lease number, the devices by contract, new location and system, transaction detail, or a shopping list. The name of the configuration and/or location is also selected as well as the degree of detail.

A report of an entire configuration provides information about the configuration and includes all locations, systems and devices in the configuration. A report of a single location provides information about the configuration and the location and includes all systems and devices within the location. A single system report provides information about the configuration, location and the system and includes all devices in the system. A "devices by lessor" report provides information about all leased devices by a specified lessor and shows information about all locations and systems where such devices are installed. A "devices by lease number" report provides information about all leased devices belonging to a selected lease number and shows information about all locations and systems where such devices are installed. A "devices by contract" report provides information about all purchased devices based on a selected contact and shows information about all systems and locations where such devices are installed. Other reports are also possible.

A new location and system report provides information about new locations and systems that have been added to a proposed ("What-If") configuration. A transaction detail report provides a chronological list of all transactions created while preparing a proposed configuration. A shopping list report provides a list of

all transactions within the What-If configuration that are different from the actual configuration. Advantageously, this report specifies the devices that must be added, disposed, renegotiated or moved to change an actual configuration to a What-If configuration.

The editor 55, shown in Figure 1, stores, retrieves and edits contact information, changes the requirements and specifications of any item within a configuration, and deletes a transaction with the configuration storage 40. The editor also enables custom modification to the knowledge base 30.

Custom modifications to the knowledge base include adding a manufacturer, adding a device, adding a model, modifying and adding information about a device, creating an additional set of customer specifications for a respective device, changing the set of specifications that is defined as the default set, adding information about RAID devices, and adding or removing a custom specification of a RAID device. Throughout the instant specification, "device" or "element" refers to either hardware components, assemblies, products, etc. and/or to software products.

The knowledge base 30 is also periodically updated by information provided by a disk, online or in a CD-ROM.

In addition to storing and displaying information concerning an existing configuration, the invention enables the simulation and optimization of changes to existing configurations. Editor 55 and the display generated by the display generator 50 are used to create a new location or system, add device levels and devices, update financial and technical information, move devices, and dispose of devices as specified by a user.

The editor 55 and the display generated by the display generator 50 also allow for the creation of proposed or "What-If" configurations.

Figure 13A shows a flow chart of a transaction for creating a new location within a configuration. First, a Select New Location transaction is selected at step 100, such as by selecting a menu item on the display generated by the display generator 50 and as shown in Figure 6, for example. Then, the name of the new location is entered at step 102. Figure 13B shows an example of a display of a new location with its specifications.

Figure 14A shows a flow chart which describes the flow of a transaction for adding one or more systems to a respective location. First, a respective location is selected from the configuration tree at step 120, and a New Systems transaction is selected at step 122. The name of the new system is then entered at step 124. Figure 14B shows an example of a display showing the acquisition of a device. Here, a processor has been selected from the knowledge base and has been added to System B at the NY-Wall Street location in the configuration.

Figures 15A-15B are flow charts showing the transactions for adding a device and its associated information. At step 140 of Figure 15A, a New Acquisition transaction is selected. Then, at step 142, a device type is selected from the knowledge base and at step 144, a system is selected in the configuration tree where the device type is to be added. The new device type is added to the configuration tree at step 146. If desired, steps 142, 144 and 146 may be repeated for adding other device types at step 148. Figure 16A shows

an example where a processor was selected from the knowledge base and added to a configuration.

Thereafter, one of the newly added device types is selected from the configuration tree at step 150, and a device model is assigned to the newly added device at step 152. As step 158 shows, steps 150 and 152 are repeated for each newly added device. Figure 16B shows an example with two newly added device types.

The associated information for each newly added device is then entered. At step 160 of Figure 15B, one of the newly added devices is selected from the configuration tree. Then, at step 162, the financial tab is selected so that financial information is included. A transaction type, namely either the lease or purchase of a new device, is selected at step 164. If the device is leased, as step 166 shows, a contact and lessor are entered at step 168. Alternatively, if the device is purchased, a depreciation method is selected at step 170. Figure 16C shows an example where financial information has been entered for a newly acquired RAID device. Figure 16D shows an example where the names of contacts have been entered for the newly acquired device.

The technical tab is selected at step 172 so that technical information for the newly added device may be entered at step 174. Figure 16E shows an example where the technical information is added for a newly acquired RAID device. It should be noted that the technical information may alternatively be added before the financial information.

Then, if the newly added device includes custom in-house or manufacturer provided modifications, as shown at step 176, the custom option is selected at step 178. Custom information is then added at step 180. For

example, for a RAID device, the RAID level field and its corresponding quantity are added at step 182. Figure 16F and 16G show examples of such transactions.

Steps 160 to 182 may then be repeated for each newly added device at step 184.

Figure 17 is a flow chart illustrating the steps for updating financial and technical information. First, the Update Operation is selected at step 200, and the device in the configuration tree for which the technical and/or financial information is to be updated is selected at step 202. If the financial data is to be updated, as shown at step 204, the financial tab is selected at step 206, and updated financial data is then entered at step 208. Figure 18A shows an example where the maintenance per month amount has been updated for a RAID device.

When technical information is to be updated, as step 210 shows, the technical tab is selected at step 212, and the technical data is then updated at step 214. Figure 18B shows an example where the capacity of a RAID device is updated. The technical information may instead by updated prior to the financial information.

Other data may then be updated, as shown at step 216. The respective transaction is selected at step 218, and the data updated at step 220. Figure 18C shows an example where the lessor/contact tab has been selected so that the contact information for a RAID device of the configuration is changed.

Figure 19 depicts a flow chart illustrating a transaction in which a device is moved from one system to another. At step 240, the Move Transaction is selected. Then, the device or devices that are to be moved are selected from the configuration tree at step 242, and the

system to which the devices are to be moved is selected at step 244. As step 246 shows, steps 242 and 244 may be repeated or undone. Figure 20A shows an example of step 242 where two RAID devices have been selected, and Figure 20B shows an example of step 244.

Then, the moved device is selected from the configuration tree at step 248, and the start date for the move is entered at step 250. Steps 248 and 250 are then repeated for each device that is to be moved, as step 252 shows.

Figure 21 illustrates a flow chart showing the disposition of a device, namely the termination of the financial and technical life of the device, so that the associated costs and other requirements for the disposition of the device may be determined.

The disposition of a device is distinguished from the deletion of a device. Specifically, a device is deleted when, using the editor 55, all historical records of a device are removed to appear that the device never existed. By contrast, the disposition of a device represents the disposal of an existing device where the historical records of the device remain.

The Device Disposition Transaction is selected at step 260, and then the device that is to be disposed is selected from the configuration tree at step 262. As step 264 shows, step 262 may be repeated for each device to be disposed. Thereafter, the disposal date of the device is selected at step 266.

Significantly, the invention also allows for the creation of proposed changes to a configuration, namely a What-If configuration, so that the effects on the financial and technical requirements of such changes may be determined. The financial and technical

specifications of an existing configuration may be compared to a configuration having a proposed change. Alternatively, the financial and technical requirements of two or more proposed configurations may be compared to each other.

As an example, an existing configuration may have several DASD devices whose leases are about to expire, and it is desired that the devices be replaced with higher capacity devices. The existing DASD devices may be replaced with newer, higher capacity DASD devices or, alternatively, the existing devices may be replaced with RAID devices. The invention shows the financial and technical ramifications of the possible change to the existing configuration prior to making any acquisition so that the optimum change may be selected.

In this example, a first What-If configuration is created by copying the existing configuration, disposing the DASD devices whose leases are to expire, and then adding the new DASD devices. A second What-If configuration is created by likewise copying the existing configuration and disposing the DASD devices whose leases will expire, but then adding the RAID devices. The financial and technical specifications of the two What-If configurations may then be compared.

Figure 22A is a flow chart illustrating the creation of two or more What-If configurations according to the invention. First, an existing stored configuration is selected at step 300, and the What-If Configuration Transaction is selected as to step 302. Then, at step 304, the name of a What-If configuration is entered, and, at step 306, one or more locations, systems, device groups or devices are added, moved and/or disposed of using the transactions described above

regarding Figures 13A, 14A, 15A, 15B, 17, 19 and 21. An appropriate date range for the What-If configuration is then selected at step 308. Steps 304 to 308 may be repeated for each respective What-If configuration, as step 310 shows.

Then, the specification of two or more of the newly created What-If configurations may be compared for matching configuration tree levels and matching date ranges. The matching tree levels for two What-If configurations are selected at step 312, and then either the financial, technical, summary, contact/lessor or history tabs is selected at step 314. The selected What-If configurations are then displayed at step 316. Step 312 to 316 may be repeated for each pair of What-If configurations that are to be compared. Figure 22B shows an example where the summary information of two What-If scenarios are displayed for corresponding date ranges and system levels.

One or more charts representing the financial or technical information of the respective What-If scenarios may be generated, as Figure 23 shows. Here, one or more previously generated What-If scenarios are selected at step 380, and a configuration level from the configuration tree is selected at step 382. A common date range is selected at step 384, and one of the financial, technical or summary tabs is selected at step 386, and a chart is generated at step 388. Steps 380 to 388 may be repeated for each respective What-If scenario, as step 390 shows.

Then, if it is desirable to display the charts of two or more What-If scenarios concurrently, as step 392 shows, the charts may be resized for concurrent display. Figure 12 shows an example of two bar charts

representing the total capacity of two respective What-If scenarios.

As described above, the invention allows the management of Hardware and Software Data Centers in a substantially automated manner through the use of software which relies on a knowledge base. In creating a configuration whose total cost of ownership needs to be determined, the user is allowed access to computer programs that allow the user to define a particular configuration e.g. its location, device groups, components, costs etc. The information about the financial cost is looked up and/or calculated from information stored in the knowledge base. The information in the knowledge base is often pre-stored in the knowledge base and is provided to a user who purchases the product of the invention. In addition, the information in the knowledge base can be and often is supplemented by information that is supplied by the user. In generating hardware configurations, the invention also provides so called drop-down menus which allow the user to select devices, e.g. CPUs, memory and other storage components from drop-down menus or to individually specify them. If devices or configurations are specified for which pricing information is not available in the knowledge base, such information can be hand entered by the user for reference purposes or estimated by the user for the purpose of obtaining a rough evaluation of the costs of a particular configuration.

It should be noted that the invention may also include information about the personnel costs, such as for systems operation or technical support.

Further, it should be noted that the invention is also applicable to a manufacturing configuration.

Here, for example, the configuration may include factories or mills as a second level, machine types as a third level and specific machines or lathes as a fourth level.

As described above, this invention provides decision support capabilities in the planning and operation of a computer enterprise. Namely, the ability to accurately project the actual cost of ownership over time and to forecast the financial and technical effects of making a change of some kind to a current or hypothetical hardware/software configuration.

The preceding description has focused on embodiments that are hardware based. The following is a description of the additional capabilities provided by this invention for managing and projecting the actual costs of ownership over time of software products and a description of the interrelationships of the costs of software products with proposed hardware changes.

Licensing fees are typically determined by the computer on which the software will run. In the personal computer arena, users generally pay a single fixed fee irrespective of the size or speed of their computer. However, as one moves to larger systems possibly composed of servers, multi-user systems and/or mainframes, software licenses terms will vary. In some instances, software prices are based on the number of users, the model of CPU, the speed rating of the CPU or combinations of one or more of these factors. Additionally, these fees or prices may be for a limited period of time, and may include charges for maintenance and support.

The licensing fees charged by vendors for software used by large data centers is most often based upon the size of the CPU that software is run on. Users

are either charged a fixed amount according to which of their CPUs fall into a particular class (more commonly known as a "model group") or, they are charged according to the speed (MIPS rating) of a specific CPU. Furthermore, each vendor may use one, both or a combination of these pricing schedules.

There is no common basis or standard definition of a model group. Each vendor may establish his own model group pricing schedules separate and apart from what other vendors may use. For example, the assignee of the present invention, Isogon Corporation, may list seven processor groups for a software product covering all IBM processors and another company may define twenty groups for those same processors.

A typical computer installation may have dozens or even hundreds of active software licenses, each having its own pricing schedule.

By way of example, pricing and model group data are presented further on below in tabulated formats, i.e. tables 1, 2 and 3.

Table 1 presents one vendor's model grouping for selected IBM processors and their corresponding MIPS rating for comparison. Table 2 is a pricing schedule based upon MIPS ratings and Table 3 presents a sample price schedule by model group.

Table 1
Sample Model Groups for IBM Processors

Processor- Model			MIPS	Group
3090	15T		16.20	C
3090	17T		16.20	C
3090	18T		21.60	C
3090	25T		27.00	C
3090	28T		43.20	C
3090	100S		5.60	B
3090	110J		7.80	B
3090	120E		10.00	C
3090	120J		10.00	C
3090	120S		7.50	B
3090	150		9.80	B
3090	500J		101.00	D
3090	500S		90.00	D
3090	600E		74.00	C
3090	600J		116.00	E
3090	600S		103.00	D

Table 2 – Sample MIPS based Pricing
Products X & Y

MIPS range	X $/MIPS	Y $/MIPS	Maintenance & Support
0-50	$217	$325	15% of License Fee First 12 months are included for new licenses.
50-100	217	276	
100+	184	276	

Note: The rates in Tables 2 and 3 are <u>one-time</u> licensing rates. They are graduated, thus for a 60 MIPS CPU the first 50 MIPS would be at the 0-50 rate and the next 10 MIPS at the 50-100 rate. The model groups shown in Table 3 correspond to those in Table 1.

Table 3 - Sample Model Group Pricing Product Z

Model Group	Price	Maintenance & Support
A	$11,800	15% of License Fee First 12 months are included for new licenses.
B	15,200	
C	20,800	
D	26,450	

When a decision maker is considering a change in hardware configuration or the purchase of some additional hardware, that decision is generally because of growth (in workload) or a consolidation to save money. As hardware costs drop, performance of CPUs increase and maintenance costs escalate, data centers will choose to replace smaller, less powerful CPUs with fewer but more powerful processors. Or, alternatively, they may choose to switch to a sysplex (IBM's clustering) of multiple processors that dynamically balance CPU workloads.

Typically, one is faced with either a new licensing situation or re-licensing of an existing software product multiplied by the number of affected software licenses. For installations having dozens or even hundreds of software licenses, the ability to examine the consequences of hardware changes or optimizations becomes increasingly difficult.

By way of example, a data center may be operating two IBM 3090/28T processors, one processor performing production work and the other primarily supporting software development. Each processor would have software licenses in place according to the mix of products on each CPU. If they then choose to replace these smaller, less powerful processors with a single but larger CPU, say an IBM 3090/500S or 3090/500J, and operate all of their licensed software on it, their licensing costs would increase due to the upgrade fees for all of their licensed software. Though vendor practices differ, upgrade fees are often calculated by subtracting the amount paid for the current license from the list price of a license for the new hardware configuration.

Using the data from Tables 1, 2, and 3, the following is a simple one year comparison for those software products. Present licensing costs are computed on the basis of the production system using product X, the development system using product Y and both systems using product Z. The licensing upgrade costs of moving to either the 500S or the 500J models are computed. The original and new licensing costs are shown in the following table for comparison and because maintenance and support fees are charged as a percentage.

Software License	3090/28T Prod group C 43.2 MIPS	3090/28T Dev group C 43.2 MIPS	3090/500S group D 90.0 MIPS		3090/500J group D 101. MIPS	
License Fees	Originally Paid	Originally Paid	List	Upgrade Fee	List	Upgrade Fee
Product X	$9,374	----	$19,530	$10,156	$21,884	$12,510
Product Y	----	$14,040	27,290	13,250	30,326	16,286
Product Z	20,800	20,800	26,450	5,650	26,450	5,560
Total			73,660	**$29,056**	78,660	**$34,446**

The user will have to pay upgrade fees for products X & Y that are dramatically increased (in proportion to the MIPS rating of the proposed configuration), and, only one upgrade fee for product Z. The second license for product Z is unnecessary. However, the user will not receive any monetary credit for no longer using it.

Software costs alone are not necessarily the deciding factor. The total cost of ownership is more relevant. In order to determine the financial consequences over time of these proposed configurations, the following tables factor in some representative hardware costs to illustrate ownership costs for one year. The first table is the present configuration which establishes a baseline for comparison. The total cost of ownership (TCO) for the original 3090/28T production and development systems is $873,752.

	Production System							Development System				
	3090 /28T	Software Product X				Software Product Z		3090/28T		Software Product Y		Software Product Z
Month	Lease	Maint	License	Maint	License	Maint	Lease	Maint	License	Maint	License	Maint
1	22,500	13,500		117		260	22,500	13,500		176		260
2	22,500	13,500		117		260	22,500	13,500		176		260
.	.	.	.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.	.	.	.
12	22,500	13,500		117		260	22,500	13,500		176		260
	270,000	162,000	0	1,406	0	3,120	270,000	162,000	0	2,106	0	3,120
TCO 873,752												

Moving to a consolidated configuration using the model 500S IBM processor, the same 12 month period costs would be as follows:

	Model 500S Upgrade							
	3090/500S		Software Product X		Software Product Y		Software Product Z	
Month	Lease	Maint	License	Maint	License	Maint	License	Maint
1	39,800	21,890	10,156	244	13,250	341	5,650	331
2	39,800	21,890		244		341		331
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
12	39,800	21,890		244		341		331
	477,600	262,680	10,156	2,930	13,250	4,094	5,650	3,968
TCO	780,327							

In spite of the increased software costs, the TCO can be reduced to $780,327. For sake of comparison, the decision maker now considers a consolidation to the model 500J. The 12 month cost figures are as follows:

	Model 500J Upgrade							
	3090/500J		Software Product X		Software Product Y		Software Product Z	
Month	Lease	Maint	License	Maint	License	Maint	License	Maint
1	42,600	23,430	12,510	274	16,286	379	5,650	331
2	42,600	23,430		274		379		331
.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.
12	42,600	23,430		274		379		331
	511,200	281,16	12,510	3,283	16,286	4,549	5,650	3,968
TCO	838,605							

In the case of the IBM model 500J system, the TCO for a single year is only modestly reduced to $838,605.

Other scenarios are possible. A planning decision may consider moving from one or more separate processors to a sysplex of multiple processors that balance workloads. In this instance, multiple licenses of the same software may be involved. For example, moving from two processors to a sysplex of five may involve purchasing three additional licenses at the appropriate costs and paying upgrade fees for the other two.

While these examples are necessarily simple for the sake of clarity, one can see that when dozens or even hundreds of software products are involved, this invention becomes a valuable tool in projecting the total cost of ownership.

While this invention can, in most cases, determine and present the monthly costs and TCO of a proposed configuration from information contained in the knowledge base, the invention cannot have a perfect understanding of all possible pricing options. Accordingly, the user is provided with the ability to enter or create custom data for software products and to update information as necessary to ensure that the knowledge base properly reflects the current or proposed configuration.

In summary, the features of this invention relating software management are similar to that provided for hardware. This invention also takes into account those factors peculiar to software licensing. Some of these features are:

Knowledge base contains pricing schedules for software products;

Supports MIPS based pricing;

Supports Model Group pricing;

Contains other relevant configuration data, e.g., vendor, version, maintenance fees, etc.;

Knowledge base can be updated and custom data for software products added;

The user interface can additionally display software product information as part of the system configuration:

Listed as a separate item;

Grouped according to vendor; Note that this is directly analogous to the *Device Grouping* feature for hardware.

Ability to add or remove a software product from a configuration;

Ability to move a software product from one system to another;

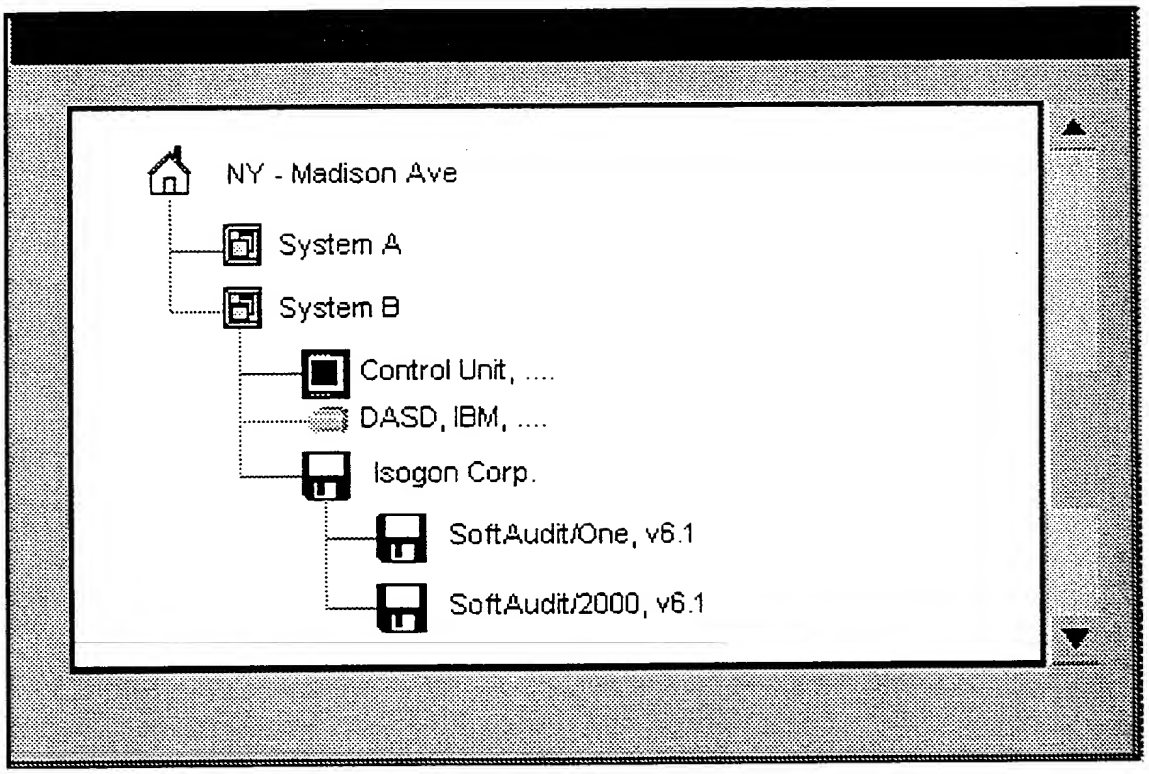
Ability to determine if a multi-product discount is applicable from a vendor;

Ability to perform a pricing comparison of a vendor's software product using both model group and MIPS based pricing when both methods are offered;

Ability to perform what-if scenarios over time to determine the total cost of ownership; and/or

Supports conventional purchase/lease pricing, custom pricing; and/or pricing based on the number of users.

A model computer screen of the invention is shown below.



While the invention has been described above in relation to the optimization of the management, purchasing and maintenance of hardware and software products, it is to be noted that the asset management invention herein is applicable to and the term "assets" includes at least: real estate, automobiles, computer hardware, computer software, collectibles, stocks, bonds, options, copyrights, trademarks, patents, etc. Thus, for example, the outright purchase of an automobile places few restrictions upon the buyer. In contrast, leasing imposes stringent time limits, payment schedules,

insurance requirements, penalties and other obligations upon the lessee. The real estate management firm may own or control numerous properties for which there may exist schedules of maintenance, capital improvements, rents due and payable, statutory requirements (income, real estate and business taxes; permits, licenses, etc.) and other obligations, each of which has one or more agreements establishing terms and conditions. The management, purchasing and optimization system of the present invention provides a tool for handling a diverse selection of "assets" as defined above.

Although the present invention has been described in relation to particular embodiments thereof, many other variations and modifications and other uses will become apparent to those skilled in the art. It is preferred, therefore, that the present invention be limited not by the specific disclosure herein, but only by the appended claims.